

Processes mediating expertise in air traffic control

Citation for published version (APA):

Van Meeuwen, L., Jarodzka, H., Brand-Gruwel, S., Van Merriënboer, J., De Bock, J., & Kirschner, P. A. (2010). *Processes mediating expertise in air traffic control*. Poster session presented at Sig 6: Instructional Design and SIG 7 Learning and Instruction with Computers, Ulm, Germany.

Document status and date:

Published: 01/08/2010

Document Version:

Peer reviewed version

Document license:

CC BY-NC-ND

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

<https://www.ou.nl/taverne-agreement>

Take down policy

If you believe that this document breaches copyright please contact us at:

pure-support@ou.nl

providing details and we will investigate your claim.

Downloaded from <https://research.ou.nl/> on date: 05 May. 2023

Open Universiteit
www.ou.nl





Processes Mediating Expertise in Air Traffic Control

Ludo W. van Meeuwen^{1,2}, Halszka Jarodzka¹, Saskia Brand-Gruwel¹, Jeroen J.G. van Merriënboer^{1,3},
Jeano J.P.R. de Bock², & Paul A. Kirschner¹

Centre for Learning Sciences and Technologies
celstec.org



¹ Open Universiteit, The Netherlands, ² Air Traffic Control, The Netherlands, ³ Maastricht University, The Netherlands

Correspondence to: Ludo.vanMeeuwen@OU.nl / Halszka.Jarodzka@OU.nl

Air traffic controllers have to take fast and correct decisions based on visualizations of the surrounding (Figure 1). These visualisations are composed of many airplanes including labels with crucial information (i.e., call sign, speeds, heading, etc.) and a number of potential routes. Despite of increasing air traffic, live of people must not be at risk. Thus, a detailed understanding of the processes underlying successful air traffic control (ATC) as well as understanding the difficulties of less experienced air traffic controllers is crucial. Such findings may inform user interface designers and instructional designers in ATC. Hence, this study examines how experts, intermediates, and novices in ATC make decisions based on stills from air traffic scenarios (cf. limited-information tasks; Hoffman, 1987) on a cognitive level (by means of verbal reports) and perceptual level (by means of eye-tracking). Moreover, the actual ATC performance and spatial ability (as potential mediator) of each participant are included in the analysis.

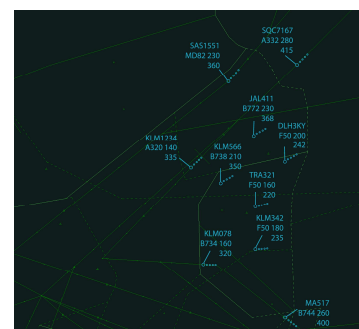


Figure 1, still of an ATC situation

Design

Knowledge Level
Experts (n=8)
Intermediates (n=8)
Novices (n=15)

X

Task Difficulty
3 x Easy
3 x Medium
3 x Difficult

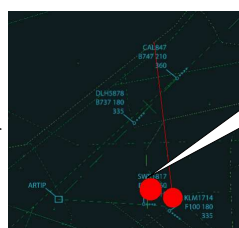
X

Spatial Ability Tests
Logical Order (Stebner et al, 2009)
Paper Folding (Ekstrom et al, 1976)
Mental Rotation (Vandenberg et al, 1978)

Procedure



Performance and
Perceptual Processes
(eye-tracking)



Cognitive Processes (Cued
Retrospective Reporting, Figure 2
(Van Gog, Paas, Van Merriënboer, & Witte, 2005)

...Here I thought...

X 9



Spatial Ability
(Questionnaires)

Hypotheses

- 1) Experts will perform more accurately and faster than intermediates, which will outperform novices.
- 2) An efficient visual search for expert (looking quickly and for a long time on relevant areas), a detailed visual search for intermediates (looking at all potentially relevant areas with many transitions), and an inefficient and course visual search for novices (looking at salient, but irrelevant areas).
- 3) Experts are expected to verbalize less information than novices due to schema automation and, thus, use fewer words in their description of how they accomplish that task. Experts' verbalizations are expected to contain more encapsulating technical terms and indicators for relevant knowledge.
- 4) Novices' strategies will be guided by the salience of single features, intermediates will follow a text-book strategy, and experts' perceptual strategies are assumed to be characterized by experience- and knowledge-based shortcuts.

References

- Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Manual for kit of factor-referenced cognitive tests*. Princeton, NJ: Educational Testing Service.
- Hoffmann, R. R. (1987). The problem of extracting the knowledge of experts from the perspective of experimental psychology. *AI Magazine*, 8, 53-67.
- Stebner, F., Lebens, M., Wirth, J., & Opfermann, M., (March, 2009). Learning from animations and static pictures: The impact spatial ability and of cognitive load. Paper presented at 3th International Cognitive Load Conference, Heerlen, The Netherlands.
- Vandenberg, S. G. & Kuse, A. R. (1978). Mental rotations, a group test of three dimensional spatial visualization. *Perceptual Motor Skills*, 47, 599-604.
- Van Gog, T., Paas, F., Van Merriënboer, J. J. G., & Witte, P. (2005). Uncovering the Problem-Solving Process: Cued Retrospective Reporting Versus Concurrent and Retrospective Reporting. *Journal of Experimental Psychology: Applied*, 11, 237-244.

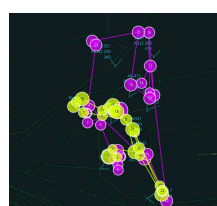


Figure 3, fixations and saccades of expert (yellow) and novice (purple)

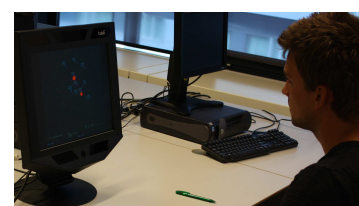


Figure 2, Cued Retrospective Reporting

Planned Analysis & First Results

21 people participated in this study, so far: novices (n=6), intermediates (n=5), and experts (n=10).

- Time on task: Experts are faster than intermediates and both are faster than novices.
- Experts and Intermediates determine traffic conflicts which novices do not observe.
- Fixation analyses: Experts show less dispersed fixations (Figure 3).
- Knowledge: The solutions of experts are grounded on more domain specific knowledge.
- Planned: AOI analyses; Sequence analyses of E.T. and performance data; Mediation analyses of spatial abilities.

Partners:



Ministerie van Verkeer en Waterstaat



Luchtverkeersleiding Nederland
Air Traffic Control the Netherlands

